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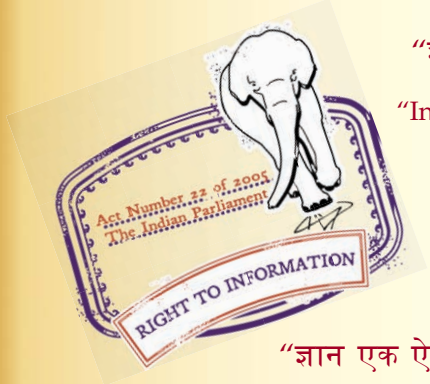
IS 10628 (1983): General requirements for aerospace bolts and nuts [TED 14: Aircraft and Space Vehicles]



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"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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UDC 621·882·2/·3 : 629·13

(Reaffirmed 2005)

Indian Standard

GENERAL REQUIREMENTS FOR AEROSPACE BOLTS AND NUTS

[Ref : Doc : EDC 74 (2152)] Aircraft and Space Vehicles Sectional Committee, EDC 74; Aircraft Fasteners, Subcommittee EDC 74 : 2

1. Scope — Specifies the general requirements for aerospace bolts and nuts made of steel, aluminium and its alloys.

2. Terminology

2.1 *Bolt and Nut* — All fasteners having external threads are referred to as 'Bolts' and those having internal threads as 'Nuts', unless otherwise specified (*see* IS : 8537 - 1977 Nomenclature and terminology of fasteners).

2.2 *Inspection Authority* — The agency expressly authorized in writing by the purchaser(s) to act on his/their behalf for inspection.

2.3 *Lot* — A lot shall consist of finished bolts or nuts which are of the same type and diameter fabricated by the same process from material of the same cast, heat-treated and plated together and produced as one continuous run free from any interruptions or changes, such as in the opinion of the Inspection Authority, might be expected to result in a significant variation in the quality of the finished product.

3. General Requirements

3.1 *Material*

3.1.1 Bolts and nuts shall be manufactured from the materials specified in the relevant bolt or nut specification.

3.1.2 Bolts or nuts may be rejected at any time for faults in or revealed by manufacture although they have been made from material passed previously.

3.2 *Manufacture*

3.2.1 The bolts and nuts shall be manufactured by any of the methods prescribed in the relevant standard.

3.2.2 Hot-forged or cold-forged steel bolts shall be manufactured by a process to fulfil the additional requirements of **5**.

3.2.3 Cold-forged aluminium alloy bolts shall be manufactured by a process to fulfil the additional requirements of **6**.

3.3 *Dimensions*

3.3.1 All bolts and nuts shall conform to the dimensions and tolerances specified in the relevant standard.

3.3.2 The selection for diameter/pitch combinations shall be made on the basis of one single pitch for each diameter as given in Table 1. In exceptional cases, the use of diameter/pitch combinations given in Table 2 is also permitted.

Adopted 29 July 1983 | | Gr 6

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

TABLE 1 DIAMETER/PITCH COMBINATIONS

(*Clause* 3.3.2)

All dimensions in millimetres.

Nominal Diameters	Pitch
3	0·5
4	0·7
5	0·8
6	1
7	1
8	1·25
9	1·25
10	1·5
12	1·5
14	1·5
16	1·5
18	1·5
20	1·5

TABLE 2 DIAMETER/PITCH COMBINATIONS (RESTRICTED)

(*Clause* 3.3.2)

All dimensions in millimetres.

Nominal Diameters	Pitch
8	1
10	1·25
12	1·25

3.3.3 Tolerance on total length of bolts for all lengths shall have a value of $\pm$ 300 μm.

3.4 *Screw Thread Form and Tolerance Classes* — The screw thread profile, wherever applicable shall conform to ISO metric thread form. The tolerance classes shall be 4h for bolts and 4H5H for nuts less than or equal to M12 × 1·5 and 5H for nuts of greater than M12 × 1·5 size.

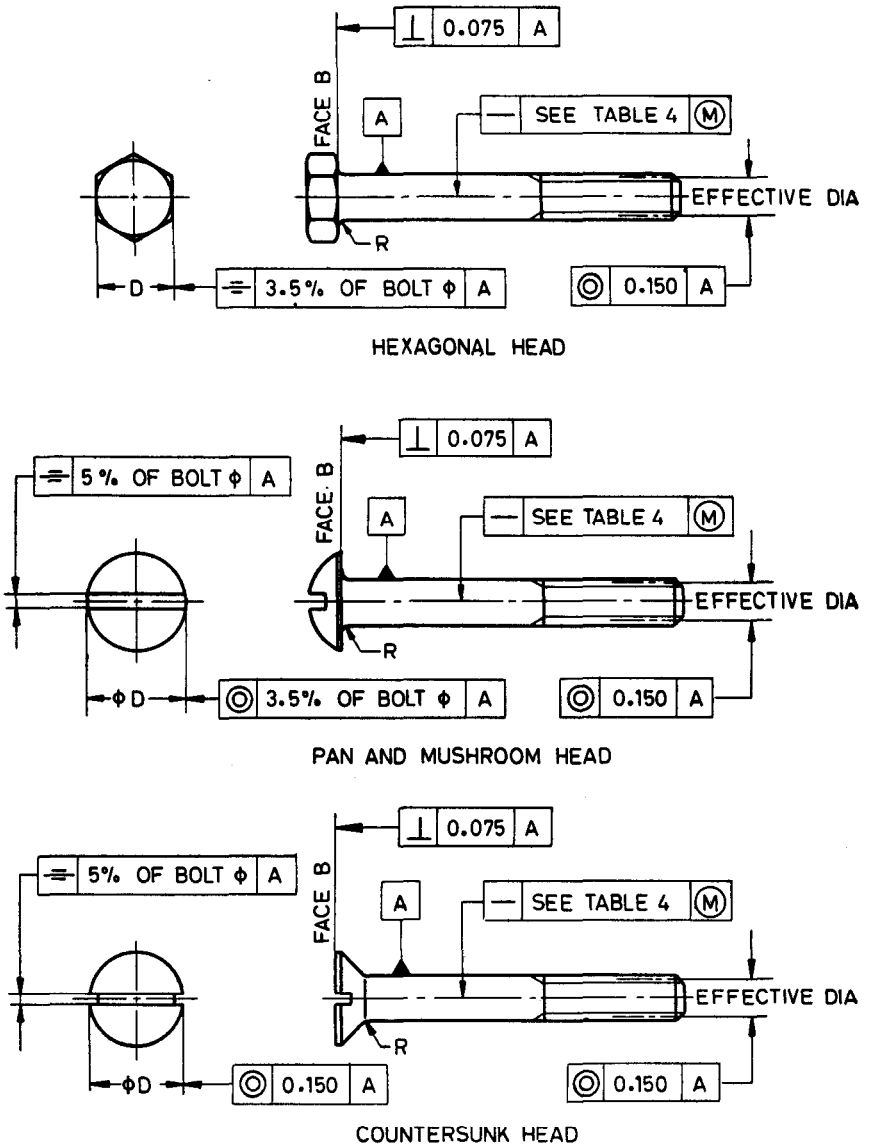
3.5 *Surface Texture* — The surface texture, determined visually, shall be as specified in Table 3. In case of disputes measurement shall be made in accordance with IS : 3073-1967 ' Assessment of surface roughness '.

TABLE 3 SURFACE TEXTURE

	Feature	Roughness Height Rating Ra	*Max* mm
Bolts	Shank, head bearing face and fillet radius	Close tolerance shank Other than close tolerance shank	0·8 1·6
	Thread flank and root-radius	Rolled thread Cut thread	0·8 1·6
	Other surfaces		3·2
Nuts	Bearing faces	Circular lay	3·2
	Other surfaces		3·2

3.6 *Geometrical Tolerances*

3.6.1 The geometrical features of bolts shall comply with the tolerances shown in Fig. 1 and Table 4.



Note — Fillet radius *R* to blend smoothly with face and shank.

All dimensions in millimetres.

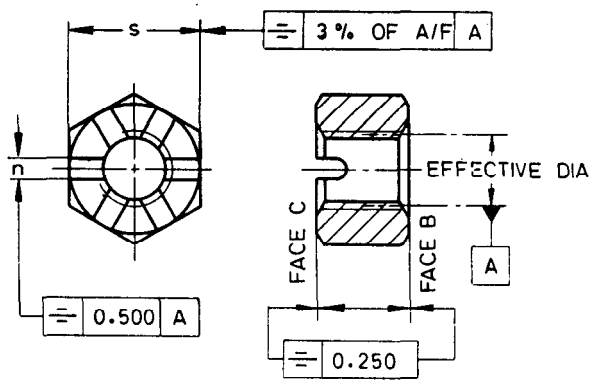
FIG. 1 GEOMETRICAL TOLERANCES FOR BOLTS

TABLE 4 GEOMETRICAL STRAIGHTNESS TOLERANCES FOR BOLT SHANKS

All dimensions in millimetres.

Nominal Size of Bolt	Straightness Tolerance	
	Close Tolerance	Other than Close Tolerance Shank Bolts
M 3 M 4 M 5	0·15% of bolt length plus a constant of 0·025	0·30% of bolt length plus a constant of 0·050
M 6 M 8	0·12% of bolt length plus a constant of 0·025	0·25% of bolt length plus a constant of 0·050
M 10	0·10% of bolt length plus a constant of 0·025	0·20% of bolt length plus a constant of 0 050
M 12	0·07% of bolt length plus a constant of 0·025	0·15% of bolt length plus a constant of 0·050
M 14 M 16 M 18 M 20	0·05% of bolt length plus a constant of 0·025	0·10% of boltlength plus a constant of 0·050

3.6.2 The geometrical features of nuts shall comply with the tolerances shown in Fig. 2.



All dimensions in millimetres.

FIG. 2 GEOMETRICAL TOLERANCES FOR NUTS

3.6.3 The squareness between the nut bearing faces and the screw thread shall comply with the tolerances given in Table 5 when checked with a squareness gauge using the method described in Appendix A.

TABLE 5 NUT SQUARENESS TOLERANCE

All dimensions in millimetres.

Nominal Size of Nut	Squareness Tolerance
M 6	0·150
M 8	0·150
M 10	0·150
M 12	0·200
M 14	0·200
M 16	0·230
M 18	0·230
M 20	0·230

3.7 *Surface Treatment* — Bolts and nuts shall generally be supplied in a well-cleaned condition and suitably protected unless otherwise agreed to between the suppliers and the purchasers. The surface treatment shall be as specified in the relevant standard.

4. Acceptance Tests

4.1 *General*

4.1.1 Except where 100 percent inspection is specified, random samples shall be taken from each lot in accordance with **4.1.2** for dimensional and visual inspection.

4.1.2 *Samples for dimensional inspection* — Samples for dimensional inspection shall be taken from each lot in accordance with IS : 2500 (Part 1)-1973 ' Sampling inspection tables, Part 1 Inspection by attributes and by count of defects ' and according to the inspection levels shown in Table 6. The acceptance or rejection shall depend upon the acceptable quality levels (AQL) applied to the characteristics as shown in the table.

TABLE 6 INSPECTION LEVELS

AQL	Inspection Level I	Inspection Level IV
1·0	Thread run-out Underhead radius Squareness Driving geometry	Thread size Shank Diameter
2·5	Plain shank length Straightness of shank Concentricity	Surface texture (visual) Burrs and plating (visual) Identification (visual)
4·0	Head height	Nut thickness Overall length Shank diameter (where tolerance exceeds 0·025 mm) Point chamfer (visual) Other dimensional characteristics

4.1.3 *Samples for non-destructive inspection* — Sampling for magnetic flaw detection/penetrant flaw detection shall be as given in Table 7, read with IS : 2500 (Part 1) - 1973.

TABLE 7 SAMPLING SCHEME FOR NON-DESTRUCTIVE INSPECTION

Lot Size	Sample Size	A_c	R_e
Single-Sampling			
Up to 10 000	200	0	—
10 001 and above	800	1	—
Double-Sampling			
n_1	500	0	2
n_2	500	1	2

4.2 *Dimensions and Gauging* — All dimensions shall be controlled by a system of gauging. The type and quality of all gauges, projection apparatus and inspecting techniques shall be to the satisfaction of the Inspecting Authority.

4.3 *Freedom from Material Defects*

4.3.1 *Magnetic flaw detection of steel bolts and nuts*

4.3.1.1 Bolts and nuts of size M4 and larger shall be subjected to magnetic particle flaw detection to indicate any discontinuities, such as cracks, seams, inclusions, etc.

4.3.1.2 The indication of discontinuities in ferro-magnetic bolts, such as cracks, seams and inclusions shall be determined by magnetic particle inspection in accordance with IS : 3703 - 1980 'Code of practice for magnetic particle flaw detection (*first revision*)'. Such inspection shall in general be performed on finished bolts but, in any case, subsequent to any operations which could have any adverse effect. The magnetising field shall be parallel to the longitudinal axis of the bolt, primarily for the indication of transverse defects. Defects along the longitudinal axis of the bolt shall, however, be detected by circular magnetisation.

Similar methods shall be applied for nuts to detect flaws in the transverse and longitudinal directions.

Demagnetisation shall be to the satisfaction of inspection authority.

4.3.2 *Penetrant flaw detection of aluminium alloy bolts and nuts*

4.3.2.1 Finished aluminium alloy bolts and nuts shall be anodized according to relevant material specification. The bolts shall be examined after this treatment and the presence of any defects as indicated by chromic acid stains shall be accepted as cause for rejection.

4.3.2.2 Indication of discontinuities, such as cracks, seams, and inclusion in aluminium alloy bolts and nuts shall be determined by penetrant flaw detection for sizes M4 and larger.

4.3.2.3 Alternatively a penetrant flaw detection shall be performed in accordance with IS : 3658-1981 'Code of practice for liquid penetrant flaw detection (*first revision*)'.

5. Additional Requirements for Cold-Forged and Hot-Forged Steel Bolts

5.1 *General*

5.1.1 A cold- or hot-forging process schedule relating to head forming technique and to the grain flow in the upset portion shall be approved by the Inspecting Authority.

5.1.2 After each forging machine setting, a minimum of twelve blanks shall be produced under full running conditions; the last two blanks shall be taken for macro examination. Any change of material, primary tools or machine setting shall necessitate re-examination.

5.1.3 All bolts shall be hardened and tempered as specified in the relevant material specification.

5.2 *Grain Flow Examination*

5.2.1 If the manufacturing process includes machining in excess of 0·125 mm of the bearing surface of the head or the adjacent, shank samples of the finished bolts at the rate of two per lot shall be taken and grain flow examined.

5.2.2 Grain flow lines of upset heads, when an etched section through a bolt is examined using a 10 × magnification, shall be to the satisfaction of Inspecting Authority.

5.3 *Internal Defects*

5.3.1 Macro test pieces taken according to **5.1.2** shall be used to reveal any laps or cracks in the head.

5.3.2 In addition, for hot-forged bolts, micro test pieces shall be suitably etched and examined for overheating to the satisfaction of Inspecting Authority.

5.4 *Decarburization and Carburization*

5.4.1 If the compliance of the material with decarburization requirements has been confirmed by the Inspecting Authority, it is necessary only to determine decarburization or carburization due to heat treatment process. For this purpose one sample shall be taken from the beginning and one from the end of each hardening cycle.

5.4.2 The examination shall be made on a longitudinal section to include the cut-off surface and/or end threads with 100 to 200 × magnification.

5.4.3 If the depth of identifiable decarburization or carburization at the cut-off surface due to heat treatment exceeds 0·050 mm, the lot of bolts represented shall be rejected.

5.5 *Mechanical Properties*

5.5.1 The mechanical properties shall be established at the discretion of the Inspecting Authority either from test samples representative of each diameter of bolt processed with each lot or from actual bolts of sufficient size.

5.5.2 The test pieces shall be tested using the method described in Appendix B.

5.5.3 The mechanical properties of the test pieces shall be as specified in the relevant bolt standard.

5.6 *Tests for Uniformity of Heat Treatment*

5.6.1 Hardness and tensile tests shall be carried out on bolts which have been heat-treated in order to determine the uniformity of heat treatment.

5.6.2 Bolts of nominal size up to and including M16 shall be tensile tested for which a minimum of ten finished bolts from each lot shall be taken. All bolts of nominal size above M16 shall be tested for hardness.

5.6.3 The tensile strength test shall be as follows:

An ordinary nut or its equivalent in the form of an adaptor shall be screwed on the bolt so as to be clear of the run-out of thread towards the head and also clear of any imperfect threads at the point. The load shall then be applied to the head and to the nut or adaptor. In the calculation, the cross-sectional area A_s of the thread shall be based on the formula:

$$A_s = \frac{\pi (d_2 + d_3)^2}{4}$$

where

d_2 = basic pitch diameter, and

d_3 = basic minor diameter.

5.6.4 The hardness test shall be done in accordance with the relevant standards on the head or on the end face of the thread. The hardness value shall not fall outside the range given in Table 8.

TABLE 8 BOLT HARDNESS RANGES

(*Clause* 5.6.4)

Tensile Strength	Hardness		
MPa	Vickers* *HV*	Brinell† *HB*	Rockwell‡ *HRC*
850-1 000	258-330	245-314	25-35
850-1 080	258-340	245-323	25-36
900-1 100	270-348	256-330	27-37
1 100-1 250	348-390	330-370	37-41

Note — In the event of a dispute the Vickers hardness shall take precedence.

*IS : 1501-1968 Method for Vickers hardness test for steel.
†IS : 1500-1968 Method for Brinell hardness test for steel.
‡IS : 1586-1968 Method for Rockwell hardness test (B and C scales) for steel.

6. Additional Requirements for Cold-Forged Aluminium Alloy Bolts

6.1 *General*

6.1.1 A cold-forged process schedule relating to head-forming technique and to the grain flow in the upset portion shall be approved by the Inspecting Authority.

6.1.2 The grain flow in the bolt shall be to the satisfaction of the Inspecting Authority who may periodically select sample bolts for sectioning and etching.

6.1.3 All bolts shall be solution treated and precipitation treated as specified in the relevant material specification.

6.2 *Testing*

6.2.1 One test sample taken from the same coil of wire as that from which the bolts have been made shall be included with each lot of bolts heat-treated together.

6.2.2 Tensile test pieces, prepared and tested in accordance with IS : 1816-1979 'Method for tensile test for light metals and their alloys' from heat-treated samples, shall have the mechanical properties specified in the relevant standard.

6.2.3 Uniformity of heat treatment shall be determined by Vickers hardness test on a minimum of 10 bolts of each size from each heat-treated lot. The hardness number of each bolt shall be not less than that of the tensile test piece by more than 7·5 percent but in any case shall not be less than 140. The hardness test shall be made before anodising.

6.3 No bolt shall be re-solution treated more than twice.

7. Identification Marking

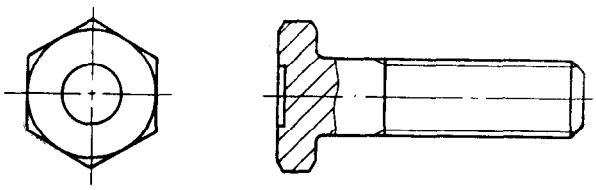
7.1 Bolts shall have the manufacturer's identification applied to the upper face of the head. Nuts shall have the identification applied on one or more of the hexagonal surfaces. Alternative identification features for bolts and nuts are given in Fig. 3 to 8.

7.2 The method of marking shall be by raised or depressed characters. The depressed characters shall be not greater than 0·25 mm in depth and shall be of rounded root form.

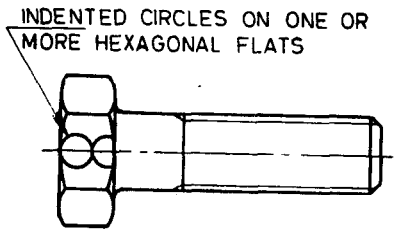
8. Packaging

8.1 Bolts and nuts shall be packed as to prevent damage during handling, transportation and storage. Bolts and nuts of one lot and part number shall be packed in unit packages, which may contain 10, 25, 50 and 100 numbers.

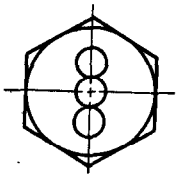
8.2 Each package shall bear the appropriate designation. In addition, the complete part number, lot identification quantity, the manufacturer's mark and where possible, a pictorial representation of the contained item shall be given on the container unless otherwise agreed upon.



Bolt with Recess

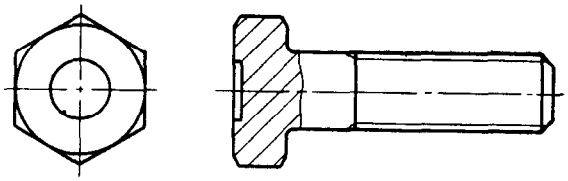


Bolt with Indented Circles on One or More of the Hex Flats

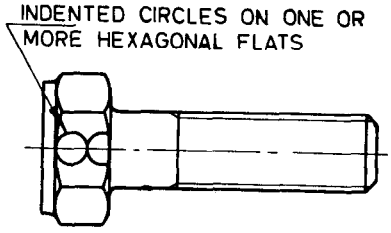


Bolt with Indented Circles on Upper Surface of Head

FIG. 3 ORDINARY BOLTS

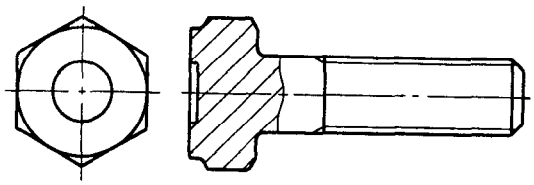


Bolt with Recess

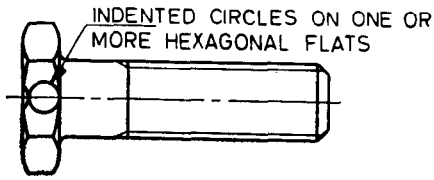


Bolt with Indented Circles

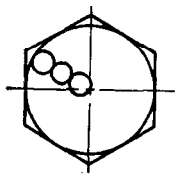
FIG. 4 BOLTS WITH CLOSE TOLERANCE SHANKS



Bolt with Recess

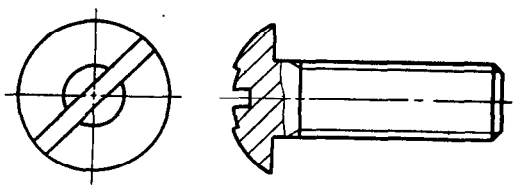


Bolt with Indented Circles on One or More of the Hex Flats

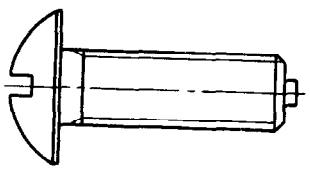


Bolt with Indented Circles on Upper Surface of Head

FIG. 5 SHEAR BOLTS

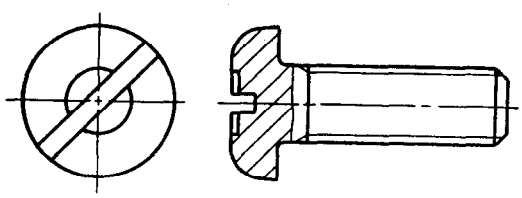


Bolt with Recess

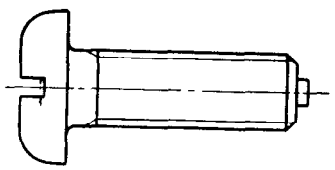


Bolt with Plain Cylindrical Extension

FIG. 6 MUSHROOM HEAD BOLTS

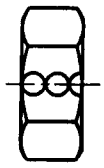


Bolt with Recess



Bolt with Plain Cylindrical Extension

FIG. 7 PAN HEAD BOLTS



Note — For convenience an ordinary nut only is illustrated.

FIG. 8 NUT

APPENDIX A

(*Clause* 3.6.3)

NUT SQUARENESS TEST

The nuts shall be screwed by hand on to a tapered truncated screw gauge until the thread of the nut is tight on the thread of the screw gauge. A sliding sleeve, having a face diameter equal to the minimum distance across flats of the nut, and a face at 90° to the axis of the screw gauge, shall then be brought into contact with the leading face of the nut. It shall not be possible for a feeler gauge of thickness equal to the squareness tolerance shown in Table 5 to enter between the leading face of the nut and the face of the sleeve as shown below:

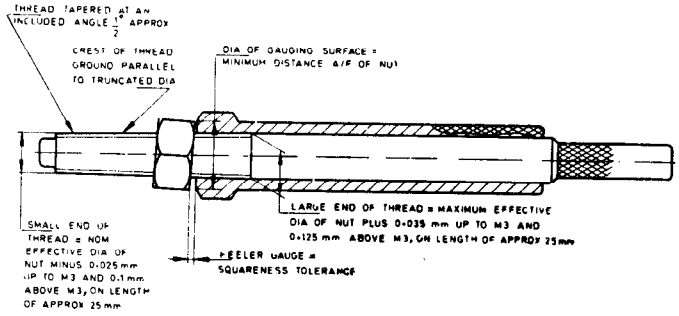


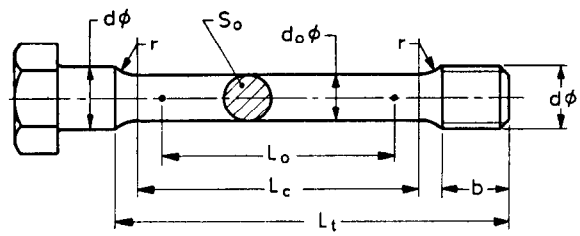
FIG. 9 NUT SQUARENESS GAUGE

APPENDIX B

(*Clause* 5.5.2)

TEST METHODS FOR MECHANICAL PROPERTIES OF BOLTS

B-1. Tensile Test for Machined Test Pieces — The tensile test shall be conducted in accordance with IS : 1608-1960 ' Method for tensile testing of steel products other than sheet, strip, wire and tube ' on a test piece as shown in the figure below:



d = nominal thread diameter
d_o = diameter of specimen (<minor diameter of thread)
b = length of thread ($\geqslant d$)
L_o = 5 d_o or ($5{\cdot}65\sqrt{S_o}$)
L_c = length of straight portion ($L_o + d_o$)
L_t = total length of specimen ($L_c + 2r + b$)
L_u = length after fracture
S_o = cross-sectional area
r = fillet radius ($\geqslant$ 4 mm)

The following properties are to be checked by this test:

a) Tensile strength, R_m

b) Proof stress, R_o at 0·1 percent permanent set,

c) Percentage elongation after fracture

$$A = \frac{L_u - L_o}{L_o} \times 100$$

The reduction of the shank diameter of heat-treated bolts and screws under 16 mm thread diameter shall not exceed 25 percent of the diameter (about 44 percent of the cross-sectional area) when preparing the test piece.

B-2. Tensile Test for Full Size Bolts — The tensile test for full size bolts shall be carried out in conformity with the tensile test on machine test piece. The tensile breaking load for the bolt shall conform to the relevant bolts specifications. When carrying out the test, a free threaded length equal to the nominal diameter of the bolt is subjected to the tensile load. To meet the requirements of this test, the fracture should occur in the shank or the thread of the bolt and not between head and the shank.

EXPLANATORY NOTE

While preparing this Indian Standard assistance has been derived from the following:

BS 2A 100: 1968 General requirements for bolts and nuts of tensile strength not exceeding 180 000 lbf/in (125 hbar) issued by British Standards Institution.

MIL — B-6812B-1967 Bolts, aircraft. Military specification USA.

This standard is intended for use in conjunction with other Indian Standards on fasteners.

Reference may also be made to ISO 5855—Part 1 and 2 ' Aerospace construction — Basic profile and dimensions for bolts and nuts — MJ threads ' issued by International Organization for Standardization.

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